

CLAIMS

What is claimed is:

- 1 1. A method for creating a magnetic head, comprising:
 - 2 adding leads to a wafer stack having a free layer, a bias layer, and a spacer layer
 - 3 between the free layer and bias layer, wherein a gap is formed between the
 - 4 leads;
 - 5 adding a protective layer to the wafer stack such that the gap is covered, the
 - 6 protective layer also covering facing ends of the leads;
 - 7 removing material from at least one side area of the wafer stack using the
 - 8 protective layer as a mask;
 - 9 removing the protective layer; and
 - 10 processing a portion of the bias layer below the gap for reducing a magnetic
 - 11 moment of the bias layer in the portion of the bias layer below the gap for
 - 12 forming a sensor in which magnetic moments of end portions of the free
 - 13 layer are pinned by magnetic moments of end portions of the bias layer.
- 1 2. The method as recited in claim 1, wherein the magnetic moments of the end
- 2 portions of the free layer are pinned antiparallel to the magnetic moments of the
- 3 end portions of the bias layer.

- 1 3. The method as recited in claim 1, wherein the leads are added to the wafer stack by an additive process.
- 1 4. The method as recited in claim 1, wherein the gap is formed between the leads by reactive ion etching.
- 1 5. The method as recited in claim 1, wherein the protective layer includes a resist undercoat and a second layer of resist above the resist undercoat.
- 1 6. The method as recited in claim 5, further comprising applying a developer to the resist undercoat for removing a portion of the resist undercoat such that opposite ends of the resist undercoat along a plane parallel to an upper surface of the wafer stack are closer together than opposite ends of the second layer of resist.
- 1 7. The method as recited in claim 1, wherein the material in the at least one side area of the wafer stack is removed by at least one of ion milling and sputter etching.
- 1 8. The method as recited in claim 1, wherein an edge of the at least one side area of the wafer stack after removing the material is oriented at an acute angle relative to a line perpendicular to a plane parallel to an upper surface of the wafer stack.
- 1 9. The method as recited in claim 1, wherein material is removed from both side areas of the wafer stack, wherein edges of the side areas of the wafer stack after

3 removing the material taper towards each other in a direction away from the wafer
4 stack.

1 10. The method as recited in claim 1, wherein the protective layer is removed by a lift
2 off process.

1 11. The method as recited in claim 1, further comprising adding lead material to the at
2 least one side area of the wafer stack.

1 12. The method as recited in claim 1, wherein the magnetic moment of the bias layer
2 is reduced by oxidation.

1 13. The method as recited in claim 1, wherein the magnetic moment of the bias layer
2 is reduced by ion implantation.

1 14. The method as recited in claim 1, wherein the magnetic moment of the bias layer
2 is reduced by milling.

1 15. The method as recited in claim 1, wherein the magnetic moment of the bias layer
2 is reduced by at least one of self-aligned oxidation, self-aligned ion implantation
3 and self-aligned milling.

1 16. A magnetic head formed by the process of claim 1.

1 17. The magnetic head as recited in claim 16, wherein end regions of the leads taper
2 towards facing ends thereof.

1 18. The magnetic head as recited in claim 16, wherein the magnetic head has no hard
2 bias elements.

1 19. The method as recited in claim 16, wherein a thickness of the bias layer in a
2 direction perpendicular to a plane parallel to an upper surface of the wafer stack is
3 less than a thickness of the free layer in the same direction.

1 20. The method as recited in claim 18, wherein the thickness of the bias layer is less
2 than about 75% of the thickness of the free layer.

1 21. A method for creating a magnetic head, comprising:
2 adding leads to a wafer stack having a free layer, a bias layer, and a spacer layer
3 between the free layer and bias layer, wherein a gap is formed between the
4 leads;
5 adding a protective layer to the wafer stack such that the gap is covered, the
6 protective layer also covering facing end regions of the leads;
7 removing material from at least one side area of the wafer stack using the
8 protective layer as a mask, wherein the protective layer includes a resist
9 undercoat and a second layer of resist above the resist undercoat;

10 applying a developer to the resist undercoat for removing a portion of the resist
11 undercoat such that opposite ends of the resist undercoat along a plane
12 parallel to an upper surface of the wafer stack are closer together than
13 opposite ends of the second layer of resist;
14 removing the protective layer; and
15 processing a portion of the bias layer below the gap for reducing a magnetic
16 moment of the bias layer in the portion of the bias layer below the gap for
17 forming a sensor in which magnetic moments of end portions of the free
18 layer are pinned antiparallel to magnetic moments of end portions of the
19 bias layer.

1 22. The method as recited in claim 21, wherein the magnetic moments of the end
2 portions of the free layer are pinned antiparallel to the magnetic moments of the
3 end portions of the bias layer.

1 23. The method as recited in claim 21, wherein the leads are added to the wafer stack
2 by an additive process.

1 24. The method as recited in claim 21, wherein the gap is formed between the leads
2 by reactive ion etching.

- 1 25. The method as recited in claim 21, wherein the material in the at least one side
2 area of the wafer stack is removed by at least one of ion milling and sputter
3 etching.

- 1 26. The method as recited in claim 21, wherein an edge of the at least one side area of
2 the wafer stack after removing the material is oriented at an acute angle relative to
3 a line perpendicular to a plane parallel to an upper surface of the wafer stack.

- 1 27. The method as recited in claim 21, wherein material is removed from both side
2 areas of the wafer stack, wherein edges of the side areas of the wafer stack after
3 removing the material taper towards each other in a direction away from the wafer
4 stack.

- 1 28. The method as recited in claim 21, wherein the protective layer is removed by a
2 lift off process.

- 1 29. The method as recited in claim 21, further comprising adding lead material to the
2 at least one side area of the wafer stack.

- 1 30. The method as recited in claim 21, wherein the magnetic moment of the bias layer
2 is reduced by oxidation.

1 31. The method as recited in claim 21, wherein the magnetic moment of the bias layer
2 is reduced by ion implantation.

1 32. The method as recited in claim 21, wherein the magnetic moment of the bias layer
2 is reduced by milling.

1 33. A magnetic head formed by the process of claim 21.

1 34. The magnetic head as recited in claim 33, wherein end regions of the leads taper
2 towards facing ends thereof.

1 35. The magnetic head as recited in claim 33, wherein the magnetic head has no hard
2 bias elements.

1 36. The magnetic head as recited in claim 33, wherein a thickness of the bias layer in
2 a direction perpendicular to a plane parallel to an upper surface of the wafer stack
3 is less than a thickness of the free layer in the same direction.

1 37. The magnetic head as recited in claim 36, wherein the thickness of the bias layer
2 is less than about 75% of the thickness of the free layer.

1 38. A magnetic storage system, comprising:
2 magnetic media;

3 at least one head for reading from and writing to the magnetic media, each head
4 having a sensor formed according to the method recited in claim 1;
5 a write element coupled to the sensor;
6 a slider for supporting the head; and
7 a control unit coupled to the head for controlling operation of the head.